CALIFORNIA BOLETES III. THE GENUS SUILLUS

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This genus of boletes is characterized by having carpophores with a viscid pileus (rarely dry, but if so with a gelatinous hypodermis), fascicled cystidia that stain dark brown to lavender or black when mounted in potassium hydroxide, relatively small, smooth-walled spores and divergent tube trama. An annulus or veil may or may not be present. A preliminary study of the North American species of *Suillus* by Smith and Thiers (1964) indicated that the genus was well represented in California. Since that time intensive collecting has shown that the genus is among the larger, if not the largest, of the Boletaceae in the state.

Presented here are detailed descriptions of new and rare species, along with comments on distribution and other characteristics of species previously described in Smith and Thiers. All colors cited in quotes are those of Ridgway (1912), and all collections are deposited in the cryptogamic herbarium of San Francisco State College, San Francisco, California. This study was made possible by a grant from the National Science Foundation (GB 2760). It is a pleasure to express sincere appreciation for collecting permits issued by Burgess Heacox of the State Parks Department and by John O'Marie of the San Francisco Water Department.

Key to Subgenera

Pileus dry, or if viscid, then stipe annulate and lacking glandular dots on the surface . . . . . Subg. *Boletinus*

Pileus subviscid to viscid to glutinous; if stipe is annulate, then glandular dots on the surface . . . . . Subg. *Suillus*

Key to Species of Subgenus Boletinus

Surface of pileus dry to moist, noticeably fibrillose to fibrillose-scaly (these characters not always apparent in very old pilei).

Pileus reddish to reddish brown to orange-buff; fibrillose scales somewhat appressed; viscid layer below scales well developed . . 10. *S. lakei* var. *lakei*

Pileus brick red to vinaceous tawny; scales prominent and more or less erect; viscid layer below scales often poorly developed. 11. *S. lakei* var. *pseudopictus*

Surface of pileus visci to glutinous or at least with viscid scales or spots; glabrous to streaked or appressed fibrillose.

Context of pileus changing to blue then fuscous when exposed; pores 1 mm or less in width . . . . . 12. *S. lithocarpi-sequoiae*

Context of pileus not changing to blue (but may change to some other color, and flesh of stipe may change to blue); pores usually greater than 1 mm broad.

Annulus moist to subviscid, not glutinous, more or less fibrillose; pileus streaked to fibrillose . . . . . 6. *S. caerulescens*

Annulus viscid to glutinous, thick, orange to yellow-orange; pileus glabrous to streaked . . . . . 15. *S. ponderosus*

KEY TO SPECIES OF SUBGENUS SUILLUS

Flesh changing to blue when exposed . . . . . 19. *S. tomentosus*
Flesh unchanging when exposed or changing to some color other than blue.
Veil or false veil present, either forming as annulus or existing as a roll of tissue on the pileus margin; (check young carpophores).
Annulus typically present.
Pores up to 5 mm broad, intervenose and often lamellate; annulus evanescent; pileus yellow to dark brown.
Pileus bright yellow; stipe short, often eccentric . . . 13. *S. megaporinus*
Pileus yellowish brown; stipe well developed, not eccentric. 18. *S. riparius*
Pores not more than 2 mm broad; annulus not evanescent; pileus tan to pale brown or olivaceous . . . . . 20. *S. umbonatus*
Annulus typically absent.
Pileus when young intensely yellow, often with red fibrils; glabrous to fibrillose; pores up to 1.5 mm broad . . . . . 3. *S. americanus*
Not as above.
Pores large, often intervenose and lamellate; annulus evanescent.
Pileus bright yellow; stipe short, often eccentric . . 13. *S. megaporinus*
Pileus yellowish brown; stipe well developed, not eccentric. 18. *S. riparius*
Not as above.
Pileus white, gray or olive when young, becoming ± ocharceous at maturity; associated with Monterey and knobcone pines. 17. *S. pungens*
Not as above.
Pileus cinnamon brown to vinaceous cinnamon; stipe 2–4 cm. long, white when young, becoming ochraceous with age. 4. *S. borealis*
Not as above.
Glandulae prominent on stipe during all stages; associated with bishop or beach pine . . . . . 8. *S. glandulosipes*
Not as above.
Pileus yellow to "ochraceous tawny" when young, often spotted or mottled; spores 8–10 × 3–4 μ . . . . 21. *S. volcanalis*
Pileus white to pallid to pale vinaceous when young; spores 6.6–8.8 × 2.5–3μ . . . . . 2. *S. albidipes*
Veil or false veil absent or rudimentary.
Pileus conspicuously fibrillose scaly to squamulose . . . . 7. *S. fuscotomentosus*
Not as above.
Stipe conspicuously glandular dotted.
Context white during all stages, unchanging when exposed; pores up to 2 mm broad . . . . . 16. *S. punctatipes*
Context yellow; pores typically less than 2 mm broad.
Taste unpleasant; spores 9.3–12μ long . . . . . 1. *S. acerbus*
Taste mild; spores 7–9μ long . . . . . 9. *S. granulatus*
Stipe not conspicuously glandular dotted.
Stipe clavate to venticose; yellow to olive buff to pale brown. 14. *S. monticolus*
Stipe ± equal, often short; white to pallid . . . . . 5. *S. brevipes*

1. SUILLUS ACERBUS Smith & Thiers, Contr. Monogr. N. Am. Species Suillus. 103. 1964.

Originally described from collections made in the Presidio, San Francisco Co., Calif., this species has been found only in the greater San

Francisco Bay area. It apparently forms mycorrhizal associations with Monterey pine (*Pinus radiata* D. Don.) as does *Suillus pungens* Thiers & Smith with which it is frequently associated. However, *S. pungens* is distinguished by a cottony roll of veil tissue on the pileus margin and a pallid to gray color on the young pileus. *Suillus acerbus* seems most closely related to *Suillus granulatus* (Fr.) Kuntze but has larger spores and an unpleasant taste. The range of the two species apparently does not overlap since, so far as known, *S. granulatus* has not been reported from the Bay area.

2. Suillus albidipes (Peck) Singer, Farlowia 2:45. 1945.

As far as can be determined this species has not been reported previously from the state. Collections have been made only in the vicinity of Huntington Lake in Fresno Co. As indicated by Smith & Thiers there has been considerable confusion concerning this fungus due to the fact that Peck apparently applied this name to two distinctly different fungi—one with an annulus and one without. In our concept *S. albidipes* should be restricted to those collections lacking an annulus but possessing a roll of veil tissue on the pileus margin. In so doing this distinguishes it from *S. granulatus* with which it appears to be most closely related.

3. Suillus americanus (Peck) Snell in Slipp & Snell, Lloydia 7:39. 1944.

This well known species, although commonly found in the Pacific Northwest is apparently rare in California for it has been found only in the vicinity of Dinkey Creek near Huntington Lake in Fresno Co. The carpophores were typical and showed the distinctive characters associated with that species, including the yellow pileus with reddish streaks of fibrils, the distinct roll of veil tissue on the margin, the yellow pores and small stipe. They were growing in a coniferous forest composed of pines and firs.

4. Suillus borealis Smith, Thiers & Miller, Lloydia 28:123. 1965.

The type collection of this species was made in Idaho but collections have since been made throughout the Pacific Northwest. A single collection has been found in California in the vicinity of Willow Creek in Humboldt Co. The collection was made in a mixed forest which included pines, Douglas fir and oaks. This species is best characterized by the presence of a veil, dark colored pileus, a white stipe that slowly turns yellow, and obscure glandulae on the surface. It lacks a well developed annulus.

5. Suillus brevipes (Peck) Kuntze, Rev. Generum Plantarum 3:535. 1898.

This species occurs throughout the state wherever two and three needle pines are found, and is one of the most abundant species. Most frequently it is associated with beach pine (*Pinus contorta* Doug.) in the coastal areas and lodgepole pine (*P. murrayana* Grev. & Balf.) in alpine areas. Collec-

tions have also been made, however, where only ponderosa pine (*P. ponderosa* Doug.) was present. Unforunately its name is somewhat misleading since carpophores with stipes better than 6 cm. in length have been collected; more commonly, however, the length is 2–4 cm. It is most easily recognized by the rather dark colored pileus with a glabrous margin, and the typically short stipe that is practically devoid of glandulae.

6. SUILLUS CAERULESCENS Smith & Thiers, Contr. Monogr. N. Am. Species Suillus. 36. 1964.

This suillus appears to be associated with Douglas fir in California and has been found wherever this conifer grows. It characteristically fruits early in the fall and is often very abundant. It is one of the few species with a viscid pileus in which the flesh of the stipe, but not of the pileus, turns blue when exposed. This reaction is sometimes spotty and relatively slow and ample time must be allowed for the change to occur. Some difficulty might be encountered in distinguishing it from *S. ponderosus* Smith & Thiers, but the latter is usually much more brightly colored and has a heavy annulus which is glutinous and bright orange, yellow-orange or tawny in color. *S. caerulescens* occurs throughout the Pacific Northwest.

7. SUILLUS FUSCOTOMENTOSUS Thiers & Smith, Contr.. Monogr. N. Am. Species Suillus. 65. 1964.

This very distinctive species was described from collections made in the sand hills area near Felton, Santa Cruz Co. It was commonly found in places where ponderosa pine and several different hardwoods were growing. Since that time, however, two additional localities have been established. One of these is in the Mount Shasta area at an altitude of 5–6,000 ft., and the other in the vicinity of Twain Harte, Tuolumne Co., at 3–4000 ft. elevation. In both localities the carpophores were obviously associated with ponderosa pine.

8. SUILLUS GLANDULOSIPES Thiers & Smith, Contr. Monogr. N. Am. Species Suillus. 86. 1964.

This is a relatively rare species in California. With the exception of a single collection made in Patricks Point State Park north of Eureka, Calif., it has only been found in Jackson State Forest near Mendocino, Calif. Although Smith & Thiers indicated that it was probably associated with beach pine, additional observations seem to indicate that it is usually associated with bishop pine (*Pinus muricata* D. Don.), in California. Since collections have been made in such widely scattered places as Michigan, Oregon and Idaho it is obvious that it has a much wider range of mycorrhizal associates than indicated here in California. It is likely to be confused with *S. granulatus* since both species fruit simultaneously, but *S. glandulosipes* is distinguished by the distinct roll of veil tissue on the pileus margin, and paler, more vinaceous color of the pileus.

9. SUILLUS GRANULATUS (Fr.) Kuntze, Rev. Generum Plantarum 3:535. 1898.

This is a very cosmopolitan species, having been reported from most of the pine forested regions of the United States, and needs little additional comment. In California it has been found in the coastal forests as well as in the mountains, and is apparently associated with two and three needle pines.

10. SUILLUS LAKEI var. LAKEI (Murr.) Smith & Thiers, Contr. Monogr. N. Am. Species Suillus. 34. 1964.

This species is relatively common in the coastal forests of the state, but rare in the mountains where only one collection has been made. Like *S. caerulescens* it is associated with Douglas fir, and has been found throughout its range of distribution. Singer (1966, 1967) has indicated that this species is synonymous with *S. amabilis* (Peck) Singer, but there appears little justification for such an assumption as will be indicated by Smith and Thiers in a forthcoming paper. This is one of the few suilli with a typically dry pileus; however, care should be taken to examine young specimens since frequently in very old pilei the fibrillose scales will have disappeared and the glatinous or viscid layer will have become very pronuonced.

11. SUILLUS LAKEI var. PSEUDOPICTUS Smith & Thiers, Contr. Monogr. N. Am. Species Suillus. 33. 1964.

Only one collection of this variety has been made in California. It was growing in mixed woods in Jackson State Forest near Mendocino, Calif. As indicated by Smith & Thiers it differs from the typical variety by being darker red in color and having a more pronounced scaly pileus.

12. SUILLUS LITHOCARPI-SEQUOIAE Singer, Mycologia 51:859. 1959.

This is the only species, so far as known, that has been reported from the state that has not been seen by either Smith or Thiers. It was described by Singer from collections made in Muir Woods National Monument in Marin Co., where it is apparently very rare since year around collecting has failed to discover it. That there is some confusion regarding its relationship with other suilli and other boletes is seen in the fact that Singer has recently transferred it to the genus *Pulveroboletus* (Singer, 1962). If, however, it has the characters elaborated by him, then it should remain in *Suillus* since it has fasciculate cystidia, small pores in connection with a viscid pileus and annulus. It appears to be the only species in the section *Boletinus* in which the flesh of the pileus consistently changes to blue when exposed.

13. SUILLUS MEGAPORINUS Snell & Dick, Mycologia 48:302. 1956.

Pileus 2–5 cm broad at maturity; globose to convex when young, becoming broadly convex to plano-convex to highly irregular with age; surface subvscid to viscid; streaked to fibrillose to appressed fibrillose scaly, scales occasionally becoming free when very old; background colored "warm buff" to "ochraceous buff", scales colored near "cinnamon buff" to "avellaneous", sometimes becoming near "ochraceous tawny" when older; margin incurved, with obscure partial veil frag-

ments when young, glabrous at maturity. Flesh 0.5–1 cm thick, colored "warm buff" to "ochraceous buff" to near "cinnamon buff," unchanging when exposed; taste and odor not distinctive. Tubes depressed becoming arcuate decurrent to strongly decurrent with age; up to 1 cm long; colored "antimony yellow" to "chamois," sometimes assuming "tawny" to "russet" tints with age; unchanging when exposed; often appearing similar in arrangement to that of *Gastroboletus turbinatus;* pores up to 5 mm in length and 3 mm broad, intervenose, almost lamellate, with thick, wrinkled, irregular margins, concolorous with tubes, unchanging when bruised. Stipe 1–3 cm long, 4–7 mm broad at apex; often appearing short and reduced; sometimes somewhat eccentric; pallid to more or less concolorous with the pileus; surface becoming conspicuously glandular dotted at maturity; no annulus but obscure fibrillose annular zone sometimes apparent; flesh concolorous with that of the pileus, unchanging. Spores ellipsoid to subfusoid to subcylindric, thin-walled, hyaline in KOH, pale yellow in Melzer's reagent, 8.5–10.5 × 4.5–6 μ; basidia hyaline in KOH, cylindric, 4-spored, 25–30 × 5–8 μ; cystidia rare on sides of tubes, abundant to crowded on pores, fascicled, no solitary cystidia seen; dark brown in KOH, chocolate brown in Melzer's reagent, cylindric to clavate, thin-walled, heavily incrusted, 30–48 × 7–11 μ; tube trama hyaline, appearing subgelatinous in KOH, parallel to regular to obscurely divergent; hyphae 3–4 μ in diam., pileus trama loosely interwoven, homogenous hyaline to pale brown in KOH; cuticle differentiated as a layer of appressed to interwoven hyphae, gelatinous to subgelatinous in KOH, hyaline to pale buff to pale brown in KOH, "ochraceous tawny" in Melzer's reagent; hypoderm compactly interwoven, dark brown in KOH and Melzer's reagent; cuticle of stipe gelatinous in KOH, interwoven, with large clusters of caulocystidia staining dark brown in KOH, often with strong lavender tints, similar in shape and size to the cystidia on pores.

Habit, habitat and distribution. Gregarious to scattered in soil under conifers at edge of seepage areas. Carpophores usually occurring in large numbers. Known only from the general vicinity of Huntington Lake, Fresno Co., Calif., *Thiers 13423, 13440.*

Discussion. At the time the monograph by Smith and Thiers was published fresh material of this species had not been seen. Since that time, however, collections have been made in the type locality. This is a highly distinctive suillus. The arrangement of the tubes is such that it appears either diseased or gastroid, but a spore deposit was obtained. The pores are larger than in any other suillus and are so long radially that they have the appearance of lamellae. The stipe is very reduced, short and somewhat eccentric. Like *S. americanus* it sometimes has reddish streaks or fibrils on the surface but it does not resemble that species otherwise. In Snell and Dick's description (1956) they noted that an ample annulus was sometimes present. This was not apparent on any of the carpophores seen although a fibrillose annular

zone could be detected on some. This species may be somewhat closely related to *S. riparius* Thiers since both species have rather large, intervenose pores, but the latter has a well developed stipe, much darker colored pileus, with a rough, scaly surface, larger cystidia and a hymeniform type of cuticle on the stipe.

14. **Suillus monticolus** Thiers, sp. nov. Pileus 4–7 cm latus, convexus demum plano-convexus, viscidus, appresso-fibrillosus, olivaceous vel cinnamomeus, in margine glaber, evelatus; tubuli 2–5 mm longi, straminei vel luridi; pori 1–2 mm lati; stipes 3–5 cm longus, 2–4 cm crassus, ventricosus basi bulbosus, siccus, glaber vel glandulosus, olivaceus demum cinnamomeus; sporae 8.5–11.2 × 3–4 μ, cylindricae vel subellipsoideae; cystidia cylindrica vel subclavata, 25–45 × 4–9 μ; cuticula subinnexa.

Holotype. Donner Summit, Nevada Co., California, elev. 7,200 ft., Sept. 22, 1965, *Thiers 13248* (Herbarium of San Francisco State College).

Pileus 4–7 cm broad when mature; convex when young but becoming plane to plano-convex to broadly convex to highly irregular with age; surface viscid to subviscid; streaked to fibrillose to appressed fibrillose scaly; when young colored "clay color" to "pale olive buff" to "olive buff," with age changing to "buffy brown" to dark "avellaneous" to near "cinnamon brown," more or less evenly colored although the streaks or fibrils may be slightly darker; margin incurved becoming decurved with age, glabrous during all stages of development with no evidence of a partial or false veil. Flesh 0.5–1 cm thick, white, unchanging when exposed; taste and odor not distinctive. Tubes 2–5 mm long, adnate to shallowly depressed becoming decurrent to subdecurrent with age; strongly radiately arranged; when young colored "straw yellow" to "amber yellow," darkening with age to "antimony yellow" to "old gold"; pores 1–2 mm broad, often compound, concolorous with the tubes, unchanging when bruised, often staining vinaceous in KOH. Stipe 3–5 cm long, 2–4 cm broad at the apex; sometimes eccentric, distinctly ventricose to bulbous at the base and abruptly pinched below, usually bent, sometimes almost at right angles; surface dry, glabrous when young becoming glandulose to punctate to occasionally obscurely fibrillose with age; glandulae apparent only in the apical region; concolorous with the tubes at the apex usually becoming colored near "olive buff" to "cinnamon brown" toward the base; frequently reticulate at the apex; white mycelium at the base; no evidence of an annulus or partial veil; stuffed; flesh white, unchanging when exposed. Spores cylindric to subellipsoid, hyaline in KOH, pale yellow in Melzer's reagent, smooth, thin-walled, 8.5–11.2 × 3–4 μ; basidia clavate to subcylindric, 2– and 4–spored, hyaline in KOH, 30–35 × 7–10 μ; cystidia clustered, often massed, particularly abundant on the pores, scattered to numerous on the sides of the tubes, no solitary cystidia seen, staining dark brown in KOH and Melzer's reagent, usually stan-

ing more darkly on the pores, cylindric to subclavate, 25–45 × 4–9 μ; tube trama divergent from a distinct mediostratum, hyaline in KOH, appearing gelatinous to subgelatinous in KOH, hyphae 3–6 μ broad; pileus trama loosely interwoven, homogeneous, ± hyaline in KOH; cuticle clearly differentiated as a trichodermum of ± upright to somewhat tangled hyphae with free tips, walls appearing finely incrusted, subgelatinous in KOH, staining chocolate brown in KOH, ochraceous in Melzer's reagent; hypodermis compact, closely interwoven, staining brown to ochraceous in KOH, "ochraceous tawny" in Melzer's reagent; surface of stipe hymeniform, with scattered clusters of caulocystidia similar to those on the pores; no clamp connections seen.

Discussion. The most distinctive feature of this suillus is the highly bulbous to ventricose stipe that is frequently bent and often somewhat eccentric. The glandulae, while always present, are never strongly developed. The hymeniform cuticle of the stipe also appears highly distinctive. It is gregarious in soil under lodgepole pines and is known only from the type locality.

15. SUILLUS PONDEROSUS Smith & Thiers, Contr. Monogr. N. Am. Species Suillus. 38. 1964.

This appears to be the largest species of suillus known from the United States and pilei up to 25 cm have been collected in California. So far it has been found only in the north coastal forests under Douglas fir where it frequently fruits with *S. caerulescens*. Its most distinctive features are the typically bright yellow or orange color of the rather heavy, glutinous annulus and the bright color of the often very large pileus.

16. SUILLUS PUNCTATIPES (Snell & Dick) Smith & Thiers, Contr. Monogr. N. Am. Species Suillus. 94. 1964.

A single collection of this species has been made in the vicinity of Donner Pass in Nevada Co. and, as far as known, this is the first report of its occurrence within the state. It is most probably associated with lodgepole pine but the carpophores were collected in a mixed conifer forest including other species of pines and firs. The relatively large pores that are radially arranged and the white flesh of the pileus distinguish it from *S. granulatus* with which it might be confused.

17. SUILLUS PUNGENS Thiers & Smith, Contr. Monogr. N. Am. Species Suillus. 92. 1964.

This is the most common suillus in the San Francisco Bay area and typically fruits under Monterey pine, but collections have also been made under knobcone pine (*Pinus attenuata* Lemmon). The type collection was made on the campus of San Francisco State College where it occurs in abundance during the fall season. It is distinguished by the white roll of veil tissue on the margin, the unpleasant taste and the white to gray or olive color of the pileus when young. It has been misidentified as *S. placidus* (Bonorden) Singer because in some instances

the entire carpophore is almost pure white when young and has conspicuous drops of milky exudate on the pores. However, it soon becomes colored and does not show any additional characteristics of *S. placidus*.

18. **Suillus riparius** Thiers, sp. nov. Pileus 5–12 cm latus, convexus vel plano-convexus vel planus, viscidus, glaber vel fibrillosus, brunneus vel ochraceus, velo luteo, floccoso in margine; tubuli decurrentes, 1.5 cm longi, lutei vel brunneoli; pori 4 mm longi, 3 mm lati; stipes 3–8 cm longus, 0.5–1.5 cm crassus, aequalis, subviscidus, glaber, flavus; sporae cinnamomeae, subcylindricae vel subfusoideae, 8–11.5 × 3.2–5 μ; cystidia in fasciculis, cylindrica vel subfusoidea, 35–75 × 5–10 μ; cuticula innexa.

Holotype. Pinecrest, Tuolumne Co., California, elev. 5,600 ft., Sept. 28, 1965. *Thiers 13283* (Herbarium of San Francisco State College).

Pileus 5–12 cm broad at maturity; convex to obtusely conic when young becoming plano-convex to plane to broadly convex to shallowly depressed with age, often highly irregular and undulating; surface viscid, when young smooth to glabrous to subglabrous, occasionally somewhat streaked to appressed fibrillose, typically becoming somewhat rimose to areolate to fibrillose-scaly, occasionally in very old pilei appearing somewhat squarrose scaly; when young colored "buckthorn brown" to "dresden brown" to occasionally "prouts brown," except for a cottony roll on the margin colored "antimony yellow" to "yellow ocher," scales colored "prouts brown" to "cinnamon brown" to occasionally "ochraceous tawny"; with age pileus "yellow ocher" to "old gold" to sometimes "naples yellow"' to "straw yellow" to occasionally "ochraceous tawny" to "ochraceous buff" when very old; scales typically unchanging or sometimes becoming pale vinaceous when bruised; margin when young with a pronounced, large roll of veil tissue which fades to "pale olive buff" with age, either appendiculate or glabrous to eroded with age. Flesh up to 1 cm thick, soft, colored "light ochraceous buff" to "massicot yellow" to "naples yellow," changing to "avellaneous" to "drab" after exposure; taste acid, odor not distinctive. Tubes bluntly adnate when young becoming arcuate decurrent to decurrent with age; up to 1.5 cm in length; when young colored "mustard yellow" to "amber yellow," changing to "antimony yellow" to "yellow ocher" with age, sometimes becoming brownish with age, unchanging upon exposure; pores distnctly compound, somewhat intervenose, up to 4 mm in length, 3 mm in width; margin highly uneven, concolorous with tubes, unchanging when bruised. Stipe 3–8 cm long, 0.5–1.5 cm broad at the apex; more or less equal; surface moist to subviscid, glabrous except for strongly developed, elongated, irregularly shaped glandulae which are colored "sudan brown" to "amber brown"; surface colored "amber yellow" to "massicot yellow" to "mustard yellow," often darkening slightly toward the base, frequently with a slight vinaceous tint at the base; stuffed to hollow; flesh concolorous with that of the pileus, unchanging when exposed; no annulus but fibrillose zone sometimes

apparent. Spores in mass colored "cinnamon brown" to near "mars brown" to "dresden brown." Spores subcylindric to subfusoid, hyaline to pale ochraceous in KOH, pale ochraceous in Melzer's reagent, smooth, thin-walled, 8–11.5 × 3.2–5 μ; basidia clavate to subcylindric, 2– and 4-spored, hyaline in KOH, 21–29 × 8–10 μ; cystidia clustered, scattered to numerous, more abundant on the pores, staining dark brown in KOH and Melzer's reagent; sometimes discolored only in base, incrusted with incrustations floating free in mounting medium, cylindric to subclavate to subfusoid, thin-walled, occasionally hyaline in KOH, 35–75 × 5–10 μ; tube trama hyaline in KOH, divergent from an indistinct mediostratum, subgelatinous in KOH, hyphae 3–5 μ in diam.; pileus trama interwoven, homogeneous, hyaline in KOH; hypodermis compactly interwoven, well differentiated, brown in KOH, "ochraceous tawny" in Melzer's reagent; cuticle differentiated as a layer of interwoven to tangled hyphae partially gelatinizing in KOH; staining brown in KOH and ± "ochraceous tawny" in Melzer's reagent, finely incrusted, hyphae 3–4 μ in diam.; cuticle of stipe hymeniform with large clusters of fascicled cystidia similar to those on the tubes, dark reddish brown in KOH; no clamp connections seen.

Habit, habitat and distributon. Gregarous to cespitose in vicinity of dead logs and stumps near edge of streams with ponderosa and sugar pines in general area. Pinecrest and Dodge Ridge Ski area, Tuolumne Co., California, *Thiers 13283, 13350, 13351, 13883, 13885, 13889.*

Discussion. This species occurs in large numbers along the edges of mountain streams, usually on or very near rotten stumps and logs. It is somewhat suggestive of *S. americanus* but differs in that the pileus is dark brown, and the stipe has dark brown glandulae. In addition the stipe is characteristically stouter than that reported for *S. americanus,* and the pores are yellow-brown. It might also be confused with *S. megaporinus* but the dark color of the pileus and well developed stipe make it distinct.

19. Suillus tomentosus (Kauff.) Singer, Snell & Dick, Mycologia 51:570. 1960.

This very abundant and easily recognized species occurs throughout the state in association with either beach or lodgepole pine. In a collection made in Nevada Co. the young pilei were densely covered with gray to olive colored fibrils which in older pilei changed to very bright red. Some fibrils commonly become disclosed, but it is unusual to find carpophores in which the fibrils are so intensely colored that the pileus is distinctly red overall.

20. Suillus umbonatus Dick & Snell, Mycologia 52:446. 1960.

As has been previously indicated in Smith & Thiers (1964) and Smith, Thiers and Miller (1965), there is some confusion surrounding this species and its relationship with *S. sibiricus* and *S. americanus.* Close comparisons between the three have been made, and it is now generally agreed that *S. umbonatus* characteristically possesses a dis-

tinct annulus, is colored pale watery brown to tan, lacks any reddish discoloration or fibrils on the pileus and shows no vinaceous discoloration in the flesh of the base of the stipe. *S. sibiricus* is characterized by lacking an annulus, having a much brighter and intensely yellow pileus and vinaceous discoloration in the flesh in the base of the stipe. *S. americanus,* although similar in color to *S. sibiricus,* characteristically has reddish streaks or fibrils on the pileus and a slender stipe.

Collections of *S. umbonatus* have been made annually in Jackson State Forest near Mendocino. The carpophores have always been found in mixed forests where both conifers and hardwoods were present, making it impossible to determine a specific mycorrhizal associate. A large collection was also made at Yuba Pass, elevation 6,700 ft., where the fruiting bodies appeared most intimately associated with alder but firs and pines were also in the vicinity.

21. **Suillus volcanalis** Thiers, sp. nov. Pileus 9–12 cm latus, convexus, appresso-fibrillosus, viscidus, luteus vel luridus, velo albo floccoso, conspicuo in margine; tubuli depressi, lutei, 1–1.5 cm longi; pori angulati minus quam 1 mm lati; stipes 3–6 cm longus, apice 1.5–3 cm crassus, aequalis vel ventricosus basi, solidus, non annulatus, albus, siccus, glaber, demum glandulosus, fulvus; sporae 6.6–10 $\times$3–4 μ; cylindricae vel subellipsoideae; cystidia in fasciculis, cylindrica vel subclavata, 24–47 $\times$ 5–8 μ; cuticula innexa.

Holotype. Butte Lake Campground, Lassen Volcanic National Park, Lassen Co., California., elev. 6,000 ft., June 27, 1965, *Thiers 12800* (Herbarium San Francisco State College).

Pileus 9–12 cm broad when mature; convex to irregular when young becoming plano-convex to highly irregular with an undulating margin to plane with an uplifted margin when older; surface often irregularly pitted; appearing closely appressed fibrillose to streaked; viscid; when young colored "primrose yellow" with numerous areas colored "ochraceous buff" to "ochraceous tawny," when older frequently with some areas colored "picric yellow" and others "vinaceous rufous," in some the background colored "antimony yellow" to "warm buff" with irregular areas colored "testaceous", very old carpophores colored "russet" to "tawny" with paler yellowish areas intermixed; margin strongly incurved when young, usually with a white to pallid, conspicuous roll of partial veil tissue attached, becoming decurved and glabrous with age. Flesh 1–2 cm thick, white to "pale ivory yellow" when young typically becoming "massicot yellow" in older pilei, unchanging when exposed; taste and odor not distinctive. Tubes shallowly to deeply depressed during all stages of development; 1–1.5 cm long; when young colored "straw yellow" becoming "aniline yellow" when older; unchanging when exposed; pores angular, less than 1 mm broad, concolorous with tubes; unchanging when bruised. Stipe 3–6 cm long, 1.5–3 cm broad at apex; equal to occasionally somewhat ventricose to flared at the base; surface dry, appearing glabrous to smooth; when

very old, glandulae are apparent at least in the apex; when young white except pale yellow at the apex, when older becoming "massicot yellow" at the apex and "buckthorn brown" to "ochraceous tawny" to "tawny" toward the base; dry; no annulus; solid; flesh white when young, yellowish with age; unchanging when exposed. Spores in mass colored "sudan brown" to "sayal brown." Spores cylindric to subellipsoid, hyaline in KOH, pale yellow in Melzer's reagent, smooth, thin-walled, 6.6–10 × 3–4 μ; basidia hyaline in KOH, clavate, 4-spored, 25–31 × 7–11 μ; cystidia rare to absent along sides of tubes, scattered to relatively abundant on pores, fascicled, no solitary cystidia seen, dark brown in KOH, thin-walled, bases of many appearing incrusted, cylindric to subclavate, "ochraceous tawny" in Melzer's reagent, 24–47 × 5–8 μ; tube trama hyaline, divergent from a distinct mediostratum, appearing subgelatinous in KOH, hyphae 3–5 μ in diam.; pileus trama with a compactly interwoven layer near tubes which stains dark brown in KOH, surmounted by a layer of loosely interwoven, more or less homogeneous hyphae; cuticle composed of a narrow layer of closely interwoven hyphae that appear to be heavily incrusted and stain dark brown in KOH surmounting a broad layer of interwoven hyphae, 5–6 μ in diam., which appear gelatinous in KOH, dark "ochracaeous tawny" in KOH; no clamp connections seen; cuticle of stipe interwoven, subgelatinous in KOH, occasional clusters of cystidia similar to those on the pores.

Habit, habitat and distribution. Gregarious to scattered (often buried) in cinders and humus under Jeffrey pines (*Pinus jeffreyi* Grev. & Balf.), Butte Lake Campground, Lassen Volcanic National Park, Lassen Co., California, elev. 6,000 ft., *Thiers 12800, 12777, 12915, 12930, 12931.*

Discussion. This species was most often found by uncovering "humps" in the soil under Jeffrey pine. Without exception it was found in dry cinder cone areas. It is somewhat remindful of *S. brevipes* but is readily distinguished by the distinct cottony margin of fibrillose tissue, the yellow to tawny color of the pileus which often appears distinctly fibrillose rather than glabrous and the much darker colored stipe. The spores are also longer and broader than those of *S. brevipes.*

Discussion

An analysis of the state flora shows that twenty species and one variety have been collected. Seven of these are more or less cosmopolitan, having been found throughout most of the United States; six others appear to be limited to the Pacific Coast, while eight of them seem to be restricted to California. Thus more than a third of the species may be endemic, which follows the pattern of a high percentage of endemism observed in other plants within the state.

The total of twenty species equals or exceeds the number of species reported from other regions except for the Pacific Northwest (Smith and Thiers, 1964), which has a known flora of 23 species. The absence

of *Larix* in California may be a major factor in this difference in numbers. Michigan and the northeastern United States also have approximately twenty species (Smith and Thiers, 1964). The California flora is far more varied than that of the southeastern United States since only twelve species have been reported from North Carolina (Coker and Beers, 1943), nine from Texas (Thiers, 1959), and five from Florida (Singer, 1945).

As is generally known, most, if not all, species of *Suillus* are associated with conifers. If *S. lithocarpi-sequoiae* is associated with *Lithocarpus* it will constitute the only known exception in the state. *Suillus caerulescens, S. lakei,* and *S. ponderosus* are associated with Douglas fir and all of the other species are apparently associated with pines. Along the coast beach pine and Monterey pine are most commonly involved. In the mountains, lodgepole pines are most frequently involved in mycorrhizal associations. No suilli have been found associated with any of the white pines, but such associates are known in other parts of the United States and probably occur here. Likewise no species have been found associated with either of the redwoods or with Sitka spruce.

Since most of the conifers occur either along the coast or in the mountains, species of *Suillus* occupy a similar distribution. So far eight species appear to be confined to the coastal forests, six to the mountains and six occur in both areas. It is interesting to note that in both areas the fruiting period occurs in the fall with practically no carpophores appearing in the spring. In the mountains if late summer rains occur, species of *Suillus* frequently appear in abundance in late August or early September. Generally the fruiting in the coastal areas occurs within a week or two after the onset of the rainy season. Most all species fruit at approximately the same time but *lakei, caerulescens,* and *pungens* have a considerably longer fruiting period than the others.

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